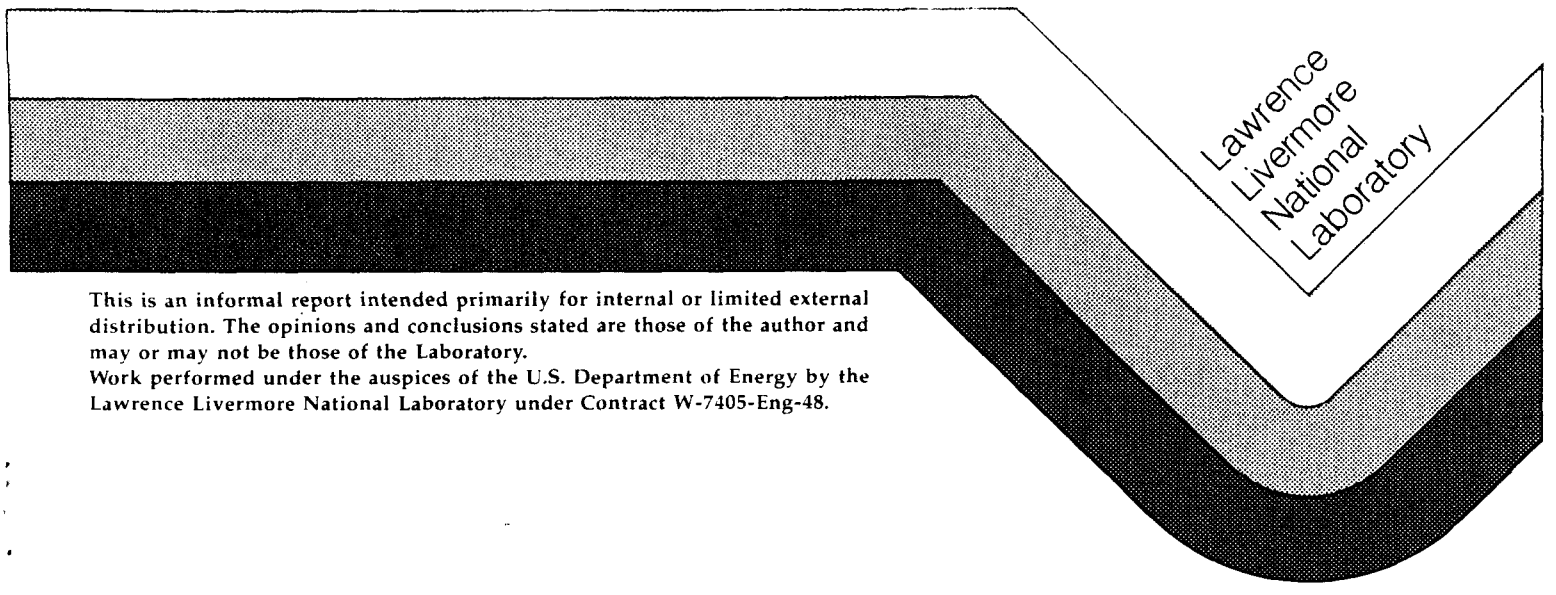
UCID- 18991-83

CALIFORNIA ENERGY FLOW IN 1983

C. K. Briggs
I. Y. Borg

October 12, 1984



Work performed under the auspices of the U.S. Department of Energy by the Lawrence Livermore National Laboratory under Contract W-7405-Eng-48.

DISCLAIMER

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Price: Printed Copy $; Microfiche $4.50

Page Range	Domestic Price	Page Range	Domestic Price
001-025	$ 7.00	326-350	$ 26.50
026-050	8.50	351-375	28.00
051-075	10.00	376-400	29.50
076-100	11.50	401-426	31.00
101-125	13.00	427-450	32.50
126-150	14.50	451-475	34.00
151-175	16.00	476-500	35.50
176-200	17.50	501-525	37.00
201-225	19.00	526-550	38.50
226-250	20.50	551-575	40.00
251-275	22.00	576-600	41.50
276-300	23.50	601-up[1]	
301-325	25.00		

[1]Add 1.50 for each additional 25 page increment, or portion thereof from 601 pages up.

Table of Contents

ABSTRACT

In 1983 California industry experienced substantial recovery from the previous 18 months' recession. Nonetheless energy use remained at 1982 levels. Oil from all sources was virtually eliminated as a fuel for electrical production. Natural gas was the single most important fuel for in-state electrical generation; coal had no place in California's fuel-mix in contrast to that of the rest of tne U.S. Geothermal energy continued to grow during 1983 and at the end of 1983 capacity reached 1.3 GWe. Nuclear energy accounted for 5% of net electricity generated in the state; at year end two nuclear plants (San Onofre 2 and 3) came on line.

Transportation demand rose slightly after a steady decline since the late 70's. Two "neat" methanol fleets are on trial in tne state--one operated by the State of California and the other by the Bank of America, and their records were excellent. Transportation is the largest energy end-use in tne state, almost twice that associated with the combined residential/commercial end-use sector and more than one-and-one-half times that of tne industrial end-use sector. In this respect California's use patterns are at odds with those of the country as a whole where these three broad end-use sectors account for more or less similar amounts of energy.

INTRODUCTION

For the past eight years, energy flow diagrams for the State of California have been prepared from available data.[1-8] They have proven to be useful tools in graphically expressing energy supply and use in the State as well as illustrating the large differences in energy use between California and the nation as a whole.

As far as possible similar data sources have been used to prepare the diagrams from year to year, and identical assumptions[2] concerning conversion efficiencies have been made in order to minimize inconsistencies in the data and analysis. In 1981, a major source of data for earlier energy flow charts was discontinued - the Quarterly Fuel and Energy Summary (QF&E), California Energy Commission (CEC). Much of the information formerly collected in QF&E is no longer published. Thus, alternate data sources, such as Department of Energy and the American Gas Association have been used in subsequent years. Data sources used in this report are given in Appendix A and B. We continue to see differences in the data reported by various agencies for the year, so comparisons of supply and usage based on new sources with previous years' analyses based chiefly on CEC data must be done with reservations. Specifically, different aggregation into industrial/commercial/residential categories occurs which bars meaningful comparisons. Nonetheless, taken overall some generalizations can be made concerning changes in the energy picture in California from year to year.

1983 CALIFORNIA ENERGY FLOW COMPARED TO PREVIOUS YEARS

Figure 1 is the flow diagram for 1983 and Figure 2 is for the previous year. Data from other years are compiled in Table 1 for comparison.

Noteworthy changes in the supply in 1983 include:

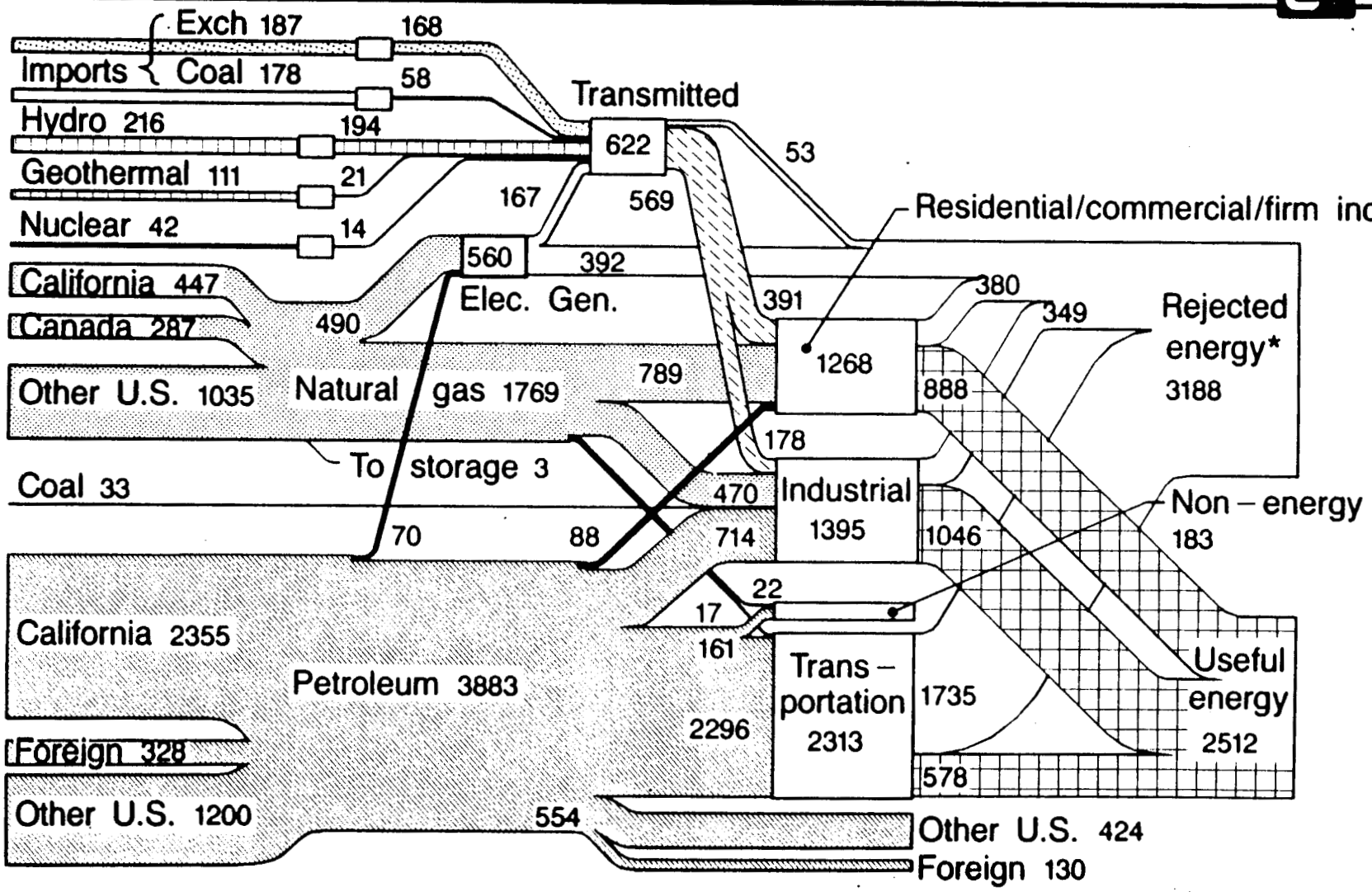
- o Continued low use of imported foreign oil
- o Another record year for indigenous California oil production
- o Large increase in California hydropower as well as imported power principally from the Pacific Northwest.

1983 saw substantial recovery from the recession of the previous 18 months by measure of such indicators as overtime hours in manufacturing, private housing starts, new business starts, unemployment rate etc. From January 1983 to December 1983 the unemployment rate dropped from 11.0% to 8.1% (Fig. 3).[9]

COMPARISON WITH U.S. ENERGY USE

Historically California's energy supply consumption patterns differ markedly from those of the U.S. as a whole (Fig. 4). The reasons relate to the indigenous petroleum industry in the state that until recently has made oil and gas fuels of convenience for most end use sectors. As the population of the state steadily increased, pollution-free fuels became desirable so that cheap coal, that has found a large market place in the Midwest and East, failed to find a market in California even for power production. Relatively pollution-free renewables such as geothermal energy, play a larger role in California than elsewhere in the United States. This reflects the presence of these unique resources within the state as well as conscious effort on the part of elected and appointed officials to promote them.

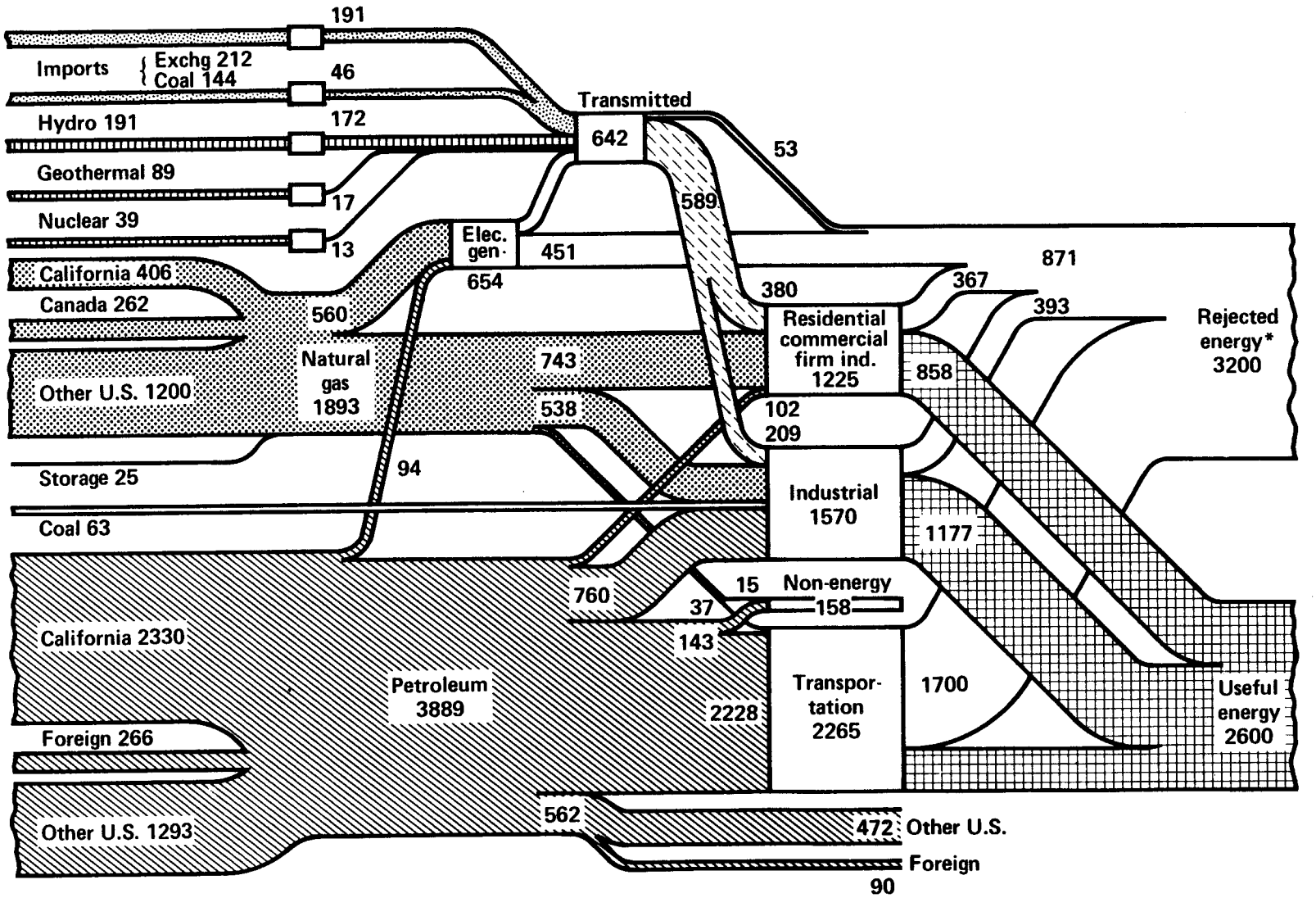
California energy flow - 1983
Total consumption 5900x10^{12} Btu



*Includes rejected energy from hydro, coal, geothermal and nuclear conversions

Figure 1.

CALIFORNIA ENERGY FLOW – 1982
TOTAL ENERGY CONSUMPTION 6000 X 10^{12} Btu



*Includes rejected energy from hydro, coal, geothermal and nuclear conversions
Data: California Energy Commission; California Division of Oil and Gas; DOE/EIA

C. Briggs/I. Borg

Figure 2.

Table 1

Comparison of Annual Energy Use in California

(in 10^{12}Btu)

	1976	1977	1978	1979	1980	1981	1982	1983
1980								
Natural Gas	1884	1831	1724	1971	1910	2010	1893	1769
Crude Oil	3886	4516	4379	4587	4391	4180	3889	3883
California Source	1921	2027	2014	2044	2071	2230	2330	2355
Foreign Imports	1606	1875	940	785	591	390	266	328
Other U.S.	359	614	1425	1758	1729	1560	1293	1200
Domestic/Foreign Exports	630	796	598	620	557	530	562	554
Net Use	3256	3720	3781	3967	3834	3650	3327	3329
Electricity								
Imports*	267	208	203	193	252	300	356	365
	(158)	(100)	(121)	(92)	(137)	(180)	(237)	(226)
Hydroelectric	94	54	144	134	164	110	191	216
Geothermal and Other	79	63	54	71	93	110	89	111
Nuclear	51	84	81	96	51	30	39	42
Gas	303	380	312	458	534	680	560	490
Oil	619	806	619	640	391	280	94	70
Total Fuel	1413	1595	1413	1592	1485	1510	1329	1294
Total Transmitted Energy	577	574	597	617	622	620	642	622
Residential/Commercial/Firm industrial	1406	1253	1321	1398	1334	1370	1225	1268
Industrial	1162	1248	1088	1216	1294	1400	1570	1395
Non-energy	222	221	239	304	298	165	158	183
Transportation	2004	2199	2438	2478	2471	2430	2265	2313
Total Energy Consumption†	5700	6000	6050	6500	6400	6300	6000	5900

* As calculated hydroelectric power or coal before conversion to electricity. Data in parentheses are actual imported Mwh from these same sources.

† Total is not sum of above figures

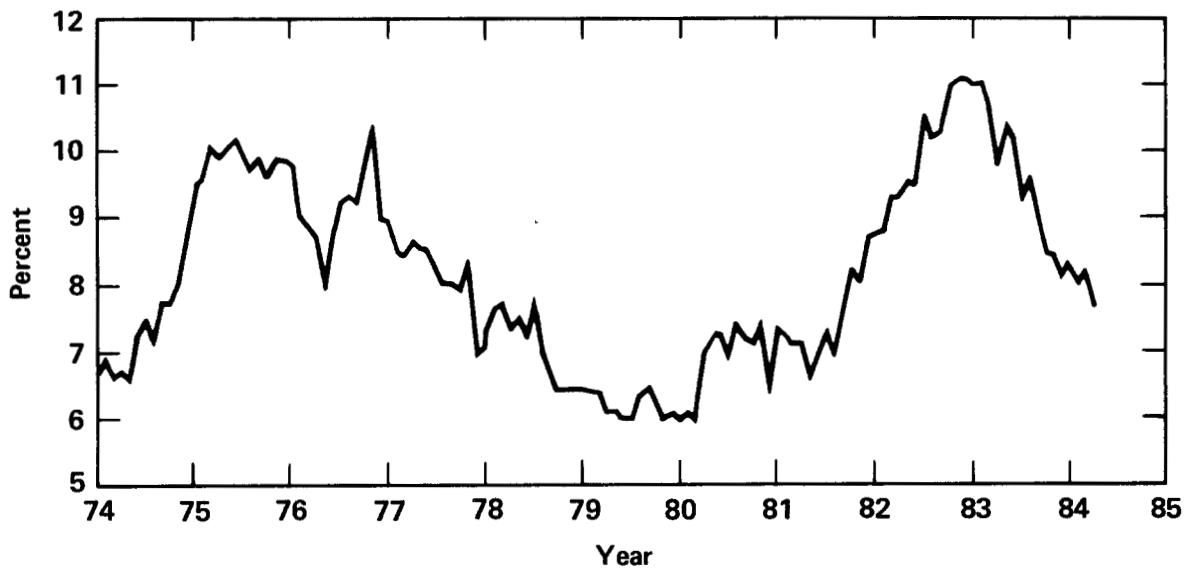


Figure 3. California Unemployment[9]

U.S. ENERGY FLOW — 1983
(NET PRIMARY RESOURCE CONSUMPTION 70 QUADS)

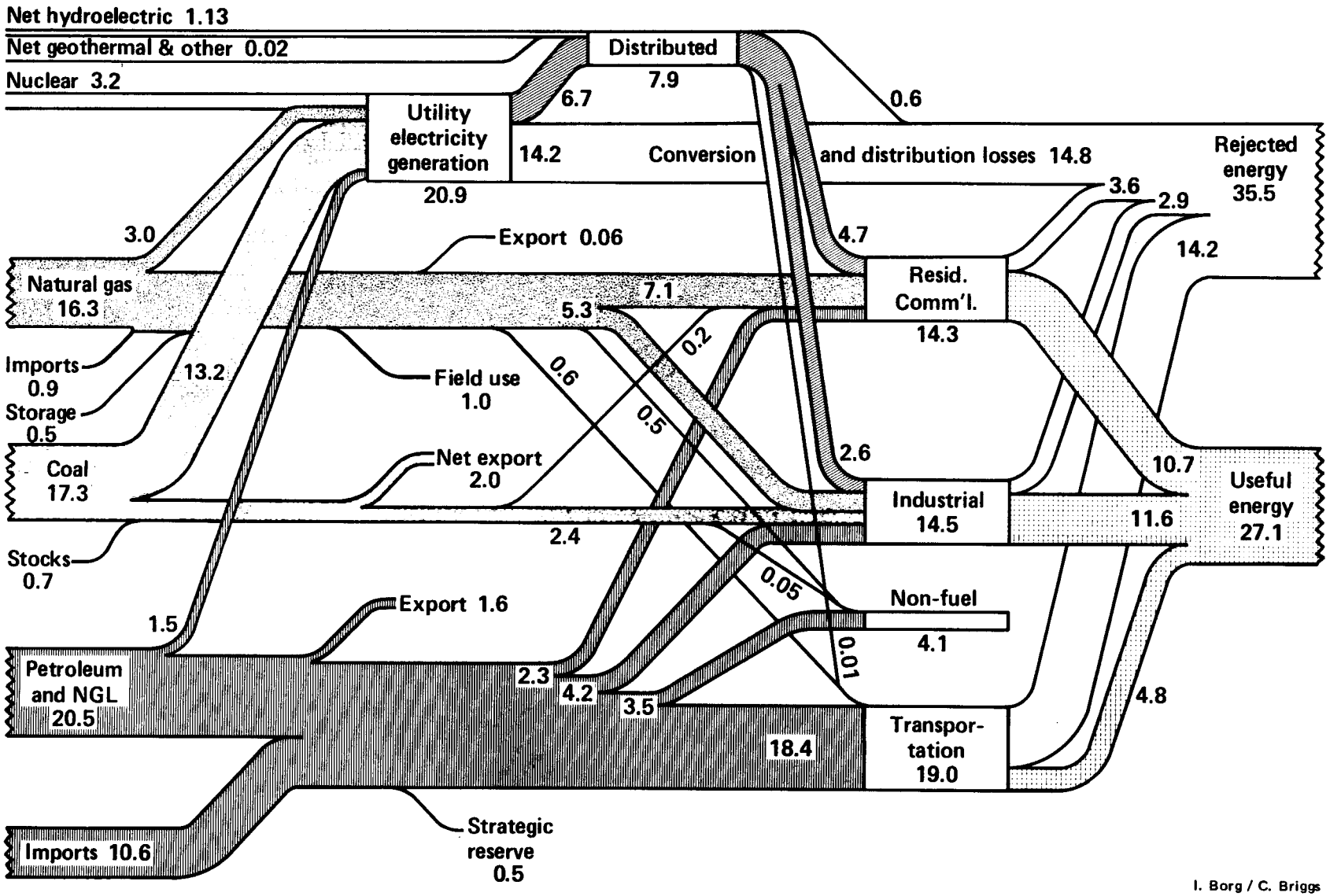


Figure 4.

Nonetheless, petroleum remains the backbone of the California energy supply. The transportation end use sector alone in California as well as in the U.S. as a whole accounts for 60% of the oil consumed. Coal in many other states meets part of the energy demand, but in California that demand is met with oil and to a lesser extent gas. Renewable energy, principally geothermal, provides 3% of the electricity power distributed in the state.

OIL AND GAS PRODUCTION

California is fourth behind Texas, Alaska and Louisiana in oil production in the U.S. and reached an all time high in 1983 due to increased production on federal offshore leases and in the Elk Hills Naval Petroleum Reserve. Elk Hills is the second largest producing field in the United States after Prudhoe Bay, Alaska. Production of oil and gas increased 14-15% at Elk Hills. Increased gas production at Elk Hills plus additional production of non-associated gas in Northern California resulted in total gas production (447 million Mcf) that neared 1973 levels but was still below the 1968 all time high of 715 million Mcf.[10] Southern California Gas Company, which buys large quantities of Canadian gas, was able to negotiate a contract with Alberta suppliers that called for purchases of just 40% of its contract volumes through 1984.[11] Previously the contract called for 73-83% "take or pay".

Small California oil producers continued to call for export of Alaskan oil to Japan in order to mitigate the growing surplus of heavy oils on the West Coast. The surplus is estimated to be 800,000 b/d and to be increasing.[12] Small producers find the cost of shipping to the Gulf Coast refineries prohibitive and are forced to accept posted prices on the West Coast no matter

how low. The Jones Act requires U.S. goods to be moved on U.S. flag ships between U.S. ports. Sixty percent of all such tonnage in the U.S. is oil shipped between Valdez, Alaska and ports in the conterminous states.[12]

ELECTRICAL POWER PRODUCTION

Source of fuels

Hydroelectric power was plentiful during 1983 from both California sources as well as from exchanges and purchases from the Western Area Power Administration and Bonneville Power Administration that makes Hoover Dam and Bonneville dam power available to the grid. Next in importance for power production is natural gas supplied by state, interstate and Canadian sources. It is burned primarily in summer months when heating demand is low. Other conventional fuels such as oil play minor roles in power production.

Nuclear power

Nuclear plants supplied 5% of net electricity generated in the state and represented 6.5% of installed capacity.[13] The small (63 MWe) Humboldt Bay-3 nuclear reactor was decommissioned when the utility owner decided that the reactor was too small to pay back the expense of making seismic modifications. It had not been restarted after it was shut-down for refueling in 1976.

San Onofre Unit 2 (1.1 GWe) came to full power mid-year, but the California Public Utility Commission declined to allow the owners (Southern California Edison and San Diego Gas and Electric) a rate increase to cover all costs of construction, which to date had been born by the utilities. By November San Onofre 3 (1.1 GWe) began producing at full power.

Fuel loading was completed at Diablo Canyon and "cold testing" began at the end of the year. At the end of 1983 California had nameplate nuclear capacity of 2.578 MWe.[13]

Geothermal power

Installed electrical capacity at the Geysers Geothermal field continued to expand and at the end of 1983 stood at 1.3 GWe. The steam fields developed at the Geysers have proven much easier to develop than the larger low to moderate temperature hot water and brine resources in the Imperial Valley. Southern California Edison operates two 10 MWe demonstration plants in conjunction with Union Oil Company at Niland and Brawley and has sought to expand the technology by building a 47 MWe dual-flash unit at Heber in cooperation with Standard Oil of California. Because the California Public Utility Commission could not guarantee the approval of passing costs on to rate payers in excess of "avoided cost" of burning oil or gas, Southern California Edison elected to find new participants in the project (Dravo Corp. of Pittsburgh, PA and Centennial Geothermal of Greenwich, CT) to build the plant.[14] When the plant comes on line in 1985, Southern California Edison will buy the power under a 30 year contract with "avoided cost" provisions.

Also starting up in 1985 is a 45 MWe binary-cycle demonstration plant at Heber planned by San Diego Gas and Electric Company. This utility is the plant's principal operator and owner, but the U.S. Department of Energy has agreed to provide one half the cost. Also participating in the project are Southern California Edison Co., California Department of Water Resources, Imperial Irrigation District, the State of California and the Electric Power Research Institute.[15] In a binary system hot brines vaporize a secondary fluid that boils at a lower temperature to drive a turbine. Such a system

eliminates air emissions, minimizes scaling and corrosion problems and is more efficient than conventional systems where brines are flashed to steam in special vessels. Another project on the order of 49 MWe is planned at Niland using a flash to steam system by Republic Geothermal Inc. and the Parson Corp. in the 1986-8 time frame.(16)

Agencies within the State Government continue to pursue a goal of 10% renewables in its electrical power mix set in the 1970's. Included in this category are wind, solar, geothermal power, and power from cogeneration and miniature dams. Conventional hydropower is not included. In 1983 it had reached 5%. Eighty-nine percent of the electrical power generated from renewable sources was from geothermal energy, primarily at the Geysers' vapor dominated fields in Lake and Sonoma Counties. The fact that ten of the 18 power plants operating in 1983 and representing 30% of capacity were on-line before 1974 suggests that geothermal power from this type of vapor-dominated geothermal field was competitive with oil and gas before prices of these fuels escalated following the 1973 and 1979 world fuel crises.

Solar and wind power

Alternative energy sources such as solar and wind power are being developed in California because of their profitability due to generous Federal and state tax credits and favorable regulations that require utilities to pay producers as much as would be paid if power were produced by conventional fuels. These conditions when combined with other investment incentives would not make solar and wind power economical in coal-burning states; however use of gas, and to a much lesser extent oil, for power production in California has made "avoided costs" sufficiently high per kwh in 1983 to ensure profitability of alternative energy forms such as wind and solar .

By the end of 1983 four photovoltaic plants were in various stages of planning and construction, and use. The largest photovoltaic plant in the world in San Bernadino County (1 MWe) went on line at tne end of 1982. Plants under construction have planned capacities up to 16.5 MWe. Of particular interest was Southern California Edison's announcement tnat it would build a 48 MWe solar pond together with Ormat Turbines Ltd, an Israeli company. In the solar pond technique highly saline water absorbs the sun's heat which is extracted near the bottom either by an internal or external heat exchanger. Electricity can be generated in a Rankine-cycle turbine.(17) The Israelis have pioneered this process. The plant in California would be the first in the United States.

California's wind mills generated 1,672 megawatt hours (Mwh) out of a net total of 133,000,000 Mwh.* Much of the nominal wind power capacity in the state came on line during 1983. The windfarms are located in the Altamont Pass, Alameda County, San Gorgonio Pass near Palm Springs, Boulevard in San Diego County and in the Tehachapis. As with solar energy, developers and owners enjoy tax credits and sell power to utilities at "avoided costs".

Cogeneration

The current boom in cogeneration is related in part to the 1983 U.S. Supreme Court decision that requires utilities to buy power generated by businesses and individuals. California, by virtue of its large oil and food industries, has been quick to take advantage of the Public Utility Regulatory Policies Act provisions which exempt such facilities from rate regulation and

*Includes 17,000,000 Mwh from out of state coal plants dedicated to California grids but excludes 49,000,000 Mwh net imports.(18)

allows them to charge utility rates near "avoided costs". But beyond that, industries that can use the steam generated at electrical power plants see cogeneration as making good business sense. These include paper and pulp companies, organizations engaged in tertiary oil production and oil refining and food processing industries. Noteworthy are the cogeneration plants located at Gilroy Foods and C&H Sugar, the Tosco Avon Oil Refinery and heavy oil recovery projects at Placerita Canyon Oil field, Kern River Oil field and the coal-fired cogeneration plant at the Belridge field. All totaled utilities purchased 729,300 Mwh from cogenerators out of the 133,000,000 Mwh of the total (net) generated in 1983.[18] Oil and gas used to cogenerate is included in total oil and gas used to generate power in Figures 1 and 2.

ELECTRICAL POWER SALES

Statewide sales fell slightly in 1983 primarily due to decline in demand in the northern part of the state serviced by Pacific Gas and Electric Company. Fuel prices paid by California electrical utilities are higher than the national average because imported gas and oil, as opposed to domestic coal, are the principal fossil fuels used for power generation and because a large fraction (36%)* of power used is purchased from the northwest and southwest sources. Average electrical costs have increased dramatically and have been borne principally by the industrial sector. A report by the California Energy Commission suggests that this has in no way affected high industrial growth in the state since it has exceeded national averages over the past decade.[19]

* Of which 9% is coal-fired electrical power generating sources in other states partially owned by California utilities.

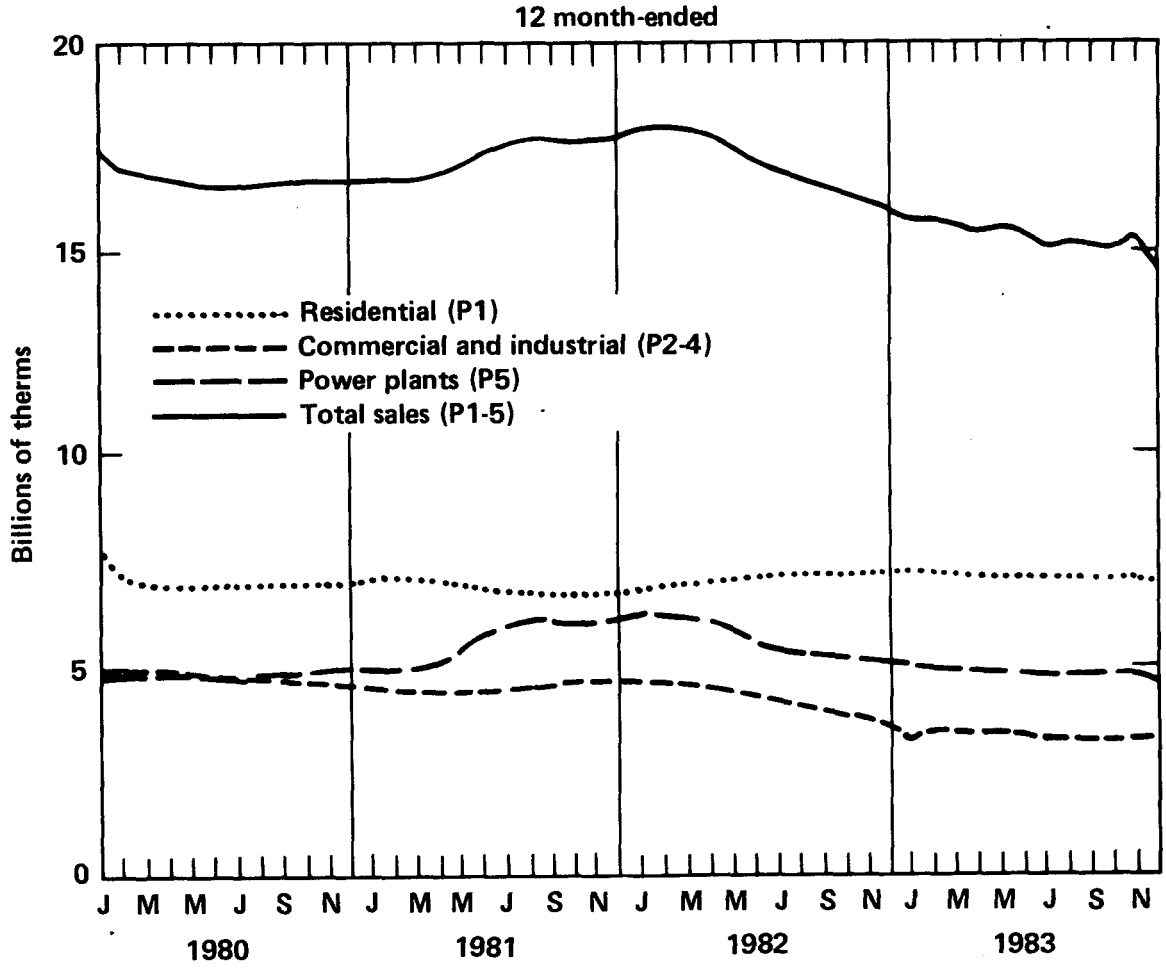


Figure 5. Natural Gas Sales
12 montn-ended data do not reflect annual seasonal variation. Source: Energy Watch, California Energy Commission, p. 5 (March 1984)

NATURAL GAS CONSUMPTION

Use of natural gas in the industrial and commercial sectors has steadily declined for the last four years (Fig. 5). By contrast residential use has stayed nearly constant despite large price increases. The state wide average residential costs

January 1982	37.8¢/therm*
January 1983	49.2¢/therm
December 1983	53.5¢/therm

increased almost 42% over the course of the year. California has "inverted rate structures" so that the "average" cost per therm to a residential customer understates the premium prices paid by many large home owners. Since 1983 was one of the mildest in several decades (Table 2), the steady gas usage in homes is difficult to explain. The annual state population increase of about 300,000 to 500,000 per year mitigates price-driven conservation and low demand associated with the mild 1982-3 and 1983-4 winters.

FUELS FOR TRANSPORTATION

Total fuels used for transportation remained slightly above 1982 levels and below levels in the 1978-81 period (Table 3). Nonetheless use of gasoline and aviation fuels was on the increase after 5 years of decline. The increases were countered by a drop in the sales of bunkering fuels. The increase in use of gasoline relates in part to recovery from the recession and in part to population increase. The smaller size of the state's automobiles continues to make in-roads into total gasoline consumption, but it is now difficult to discern since it is masked by increased usage and larger numbers in the fleet.

---

* 1Mcf = 10.5 therms

In 1983 the State of California took delivery of 506 Ford escorts that are fueled by methanol blended with 10% unleaded gasoline to improve starting. The fleet was the result of a joint program between industry and the California Energy Commission which provided almost $4 million in funds including a network of 32 fueling stations, built and operated by Celanese Corporation. This experience will augment that of the Bank of America which operates a fleet of 266 methanol-fueled Fords and GM cars. After 7 million miles of fleet driving using methanol they report "drivability has been far superior to gasoline vehicles"(20)

Table 2

WEATHER COMPARISON

1958-1983
ANNUAL HEATING DEGREE DAYS*

	San Francisco Federal Office Building	Los Angeles Civic Center	San Diego Lindbergh Field
1958	2332	849	805
1967	2978	1040	1380
1968	2942	850	1052
1969	3066	941	1137
1970	3006	941	1137
1971	3468	1424	1657
1972	3240	918	1166
1973	3161	1066	1137
1974	3182	1084	1123
1975	3313	1548	1416
1976	2665	1128	793
1977	2888	911	747
1978	2599	1208	736
1979	2545	1160	902
1980	2799	597	590
1981	2819	506	573
1982	3195	975	913
1983	2386	602	623
Normal 1941-70	3080	1245	1507

*Source Local Climatological Data, for San Francisco, Los Angeles, and San Diego.

National Oceanic and Atmospheric Administration
National Climatic Center
Asheville, N.C.

Table 3

Transportation End Use (10^{12}Btu)

	1978[4]	1979[5]	1980[6]	1981[7]	1982[8]	1983
Net Gasoline	1500	1439	1375	1384	1345	1418
Net Aviation Fuel	357	350	346	335	298	318
Taxable diesel fuel-Public Highway	149	161	160	166	161	168
Rail diesel	35	35	43	46	42	41
Net Bunkering	288	358	430	412	346	316
Military	30	30	32	42	36	35
Total	2359	2373	2386	2385	2228	2296

Source: 1983 data from Petroleum Supply Annual, 1983, DOE/EIA-0340 (83)/1 (June 1984) and Fourth Quarter 1983, Quarterly Oil Report, California Energy Commission, for net gasoline use.

Appendix A

Data Sources for California Energy Supply (1983)

Production

Crude Oil including Federal Offsnore and Lease Condensate	Ref. 21
Associated and Nonassociated Natural Gas	Ref. 21
Electric Utility Fuel Data	Ref. 22
Electrical Generation (hydro, nuclear, oil, gas, geothermal)	Ref. 18, Table S1

Imports

Natural Gas Foreign and Domestic	Ref. 23
Crude Oil Foreign and domestic	Ref. 24, Table II-3 and Table B-II
Oil Products Foreign and Domestic	Ref. 24, Table B-II
Coal	Ref. 25, Table 22
Electrical Power Net Exchange Coal	 Ref. 18, Tables S2 and S3* Ref. 26 Ref. 18, Table S1

Exports

Oil Products Foreign and Domestic	Ref. 24, Table B-II
(not including bunkering fuel supplied at California ports)	

*Southern California Edison deliveries to the Northwest and Southwest for the first and second quarters are estimates.

Appendix B

Data Sources for California End Uses (1983)

Net Storage and Field Use	
Natural Gas	Ref. 23
Transportation	
Crude Oil	
Consumption of gasoline, aviation and jet fuels	Ref. 27, p. 22
Taxable diesel fuel (i.e. for public highways)	Ref. 28, p. 126
Vessel Bunkering (includes international bunkering)	Ref. 28, p. 125, 128
Rail diesel	Ref. 28, p. 125
Military Use	Ref. 28, p. 125, 127
Natural Gas	
Lost or unaccounted for from gas utilities (transmission and pipelines)	Ref. 23
Industrial, Government, Agriculture, etc.	
Natural gas	By difference
Coal	Ref. 25, Table 22
Electricity	Ref. 29
Crude Oil	By difference
Non Energy Applications	
Crude Oil and LPG	
Asphalt	Ref. 30, Table A
Petrochemical feedstock	Ref. 28, 31*
Waxes, lubricating oils, medicinal uses, cleaning	1/3 of asphalt and road oil totals, Ref.2
Natural Gas	
Fertilizer	Ref. 29
Residential and Small Commercial	
Natural Gas	Ref. 29
Crude Oil and Other Oils (Kerosene, Residual, and Distillate)	Ref. 28, p. 129, 127, 124
LPG	Ref. 28, 31
Miscellaneous "off highway" diesel	Ref. 28, p. 126
Electricity	Ref. 29

*LPG and ethane sales data not available from EIA, product supplied data from Refs. 28, 31 and sales data reported in Ref. 31 were used to estimate 1983 sales.

Appendix C

Conversion Units

Energy Source	Conversion factor, 10^6 Btu
Electricity	3.415 per MW.h
Coal	22.6 per short ton
Natural Gas	1.05 per MCF
LPG	4.01 per barrel
Crude Oil	5.80 per barrel
Fuel Oil	
Residual	6.287 per barrel
Distillate, including diesel	5.825 per barrel
Gasoline and Aviation Fuel	5.248 per barrel
Kerosene	5.67 per barrel
Asphalt	6.636 per barrel
Road Oil	6.626 per barrel
Syntnetic Rubber and Miscellaneous LPG Products	4.01 per barrel

Assumed Conversion Efficiencies of Primary Energy Supply

Electric power generation	
Hydro power	90%
Coal	30%
Geothermal	18%
Oil and Gas	33%
Uranium	32%
Transportation Use	25%
Residential/Commercial Use	70%
Industrial Use	75%

REFERENCES

1. E. Benrin and R. Cooper, California Energy Outlook, Lawrence Livermore Laboratory Report, UCRL-51966, Rev. 1 (1976).

2. I. Y. Borg, California Energy Flow in 1976, Lawrence Livermore Laboratory Report, UCRL-52451 (1978).

3. I. Y. Borg, California Energy Flow in 1977, Lawrence Livermore Laboratory Report, UCID-18221 (1979).

4. C. Briggs and I. Y. Borg, California Energy Flow in 1978, Lawrence Livermore Laboratory Report, UCID-18760 (1980).

5. C. Briggs and I. Y. Borg, California Energy Flow in 1979, Lawrence Livermore National Laboratory Report UCID-18991 (1981).

6. C. Briggs and I. Y. Borg, California Energy Flow in 1980, Lawrence Livermore National Laboratory Report, UCID-18991-80 (1982).

7. C. Briggs and I.Y. Borg, California Energy Flow in 1981, Lawrence Livermore National Laboratory Report, UCID-18991-81 (1983).

8. C. Briggs, and I. Y. Borg, California Energy Flow in 1982, Lawrence Livermore National Laboratory Report, UCID-18991-82 (1983).

9. California Economic Indicators, California Department of Finance, Sacramento, CA, 8, 12 (May 1984).

10. DeGolyer and MacNaughton, Twentieth Century Petroleum Statistics 1983, p. 81.

11. Energy Daily 11 #88, 1 (May 9, 1983).

12. Platt's Oilgram News, 4 (August 15, 1983).

13. Electric Power Annual 1983, Department of Energy DOE/EIA - 0348(83) 15 (July 1984).

14. J. McCaughey, A California oil major plunges into geothermal, The Energy Daily, 2(September 23, 1983).

15. Oil and Gas J., 30 (December 20, 1982).

16. The Energy Daily, 12 #3, 4 (January 4, 1984).

17. D. W. Dorn, World Activity in Solar Ponds, Lawrence Livermore National Laboratory Report, UCID-18900 (January 20, 1981).

18. Energy Watch, Quarterly Supplement, California Energy Commission, Sacramento, CA (September, November 1983; February, May 1984).

19. Staff Analysis of Industrial Electricity Prices and Industrial Growth: A comparison of California and the United States, Draft, California Energy Commission, Sacramento, CA (September 1984).

20. Vehicle Conversion and Methanol Fuel Program 1980-1982, Bank of America Corporation, San Francisco, CA 245(1983).

21. 1983 California Oil aand Gas Production Statistics and New Well Operations, Preliminary Report, California Division of Oil and Gas, Report No. Pro 3 (1984).

22. Dennis Smith, Calfornia Energy Commission, personal communication of ERQFER Reports Data, Annual Electric Utility Fuel Data (July 1984).

23. Dennis Smith, California Energy Commission, personal communication of ERQFER Reports Data, Natural Gas Utility Source and Disposition (July 1984).

24. Annual Petroleum Review 1983 (Draft), California Energy Commission (April 1984).

25. Quarterly Coal Report, DOE/EIA-0121 (83/4Q).

26. Dennis Smith, California Energy Commission, personal communication (September 14, 1984).

27. Quarterly Oil Report, Fourth Quarter 1983, California Energy Commission (March 1984).

28. Petroleum Supply Annual 1983, DOE/EIA-0340(83)/1.

29. Dennis Smith, California Energy Commission, personal communication of SIC Forecast Model by End-Use (July 1984).

30. Asphalt Usage 1983, United States and Canada, The Asphalt Institute (June 1984).

31. Petroleum Supply Annual 1982, DOE/EIA-0340(82)/1.

Technical Information Department • Lawrence Livermore National Laboratory
University of California • Livermore, California 94550